Integrated Energy Master Plan
Executive Summary

for

Fort Riley, Kansas

Contract No. DACA 45-78-C-0106

Prepared for

U. S. Army Engineer District, Omaha

Corps of Engineers

Omaha, Nebraska

1980

78-808-4

Burns & McDonnell

ENGINEERS - ARCHITECTS - CONSULTANTS

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September 10, 1980

U. S. Army Engineer District, Omaha
Corps of Engineers
6014 U S Post Office and Courthouse
Omaha NE 68102

Re: Fort Riley Kansas
Interim Report
Integrated Energy Master Plan
Contract No. DACA 45-78-C-0106

Gentlemen:

We have completed the investigation, studies and analyses to determine the best opportunities for energy conservation, solar applications and alternative energy plants.

This report contains a summary of our findings, for an energy master plan.

Sincerely,

Kenneth M. Clark

Kenneth M. Clark, P.E.

Dennis M. Whitney

Dennis M. Whitney

KMC/DMW/rs

Enclosures

TABLE OF CONTENTS

PART I

INTRODUCTION

GENERAL DESCRIPTION

Fort Riley is the headquarters for the Army's 1st Infantry Division. The reservation occupies over 100,000 acres in Riley and Geary Counties in Kansas. Junction City and Manhattan are the two largest cities closest to the fort.

All troop housing, family housing, administration, repair and storage facilities are locatedin the southern portion of the reservation and is referred to as the building area. The building area of the fort consists of seven separate areas: Custer Hill Troop Housing, Custer Hill Family Housing, Camp Forsyth, Camp Whitside, Camp Funston, Marshall Airfield and the Main Post.

PURPOSE OF REPORT

The purpose of this report is to provide a systematic approach for energy conservation, develop the most efficient use of available energy sources, and present an energy master plan.

SCOPE OF STUDY

The scope of this study is to perform a complete energy analysis of Fort Riley, accomplished in the following manner:

1. Field verify existing conditions in all buildings located on the building area of the fort.
2. Prepare a computer model for a representative group of buildings.
3. Evaluate all energy saving opportunities that will reduce total fort energy consumption and develop Energy Conservation Investment Program (ECIP) projects.
4. Evaluate solar energy applications.
5. Evaluate Energy Monitoring and Control Systems (EMCS) study recently completed.
6. Evaluate use of solid waste fuel.
7. Evaluate central plant and utility distribution systems. (Steam, chilled water, electricity, gas, and potable water.)
8. Evaluate economic, feasibility of installing one or more selective energy plants.
9. Evaluate economic feasibility of installing a coal-fired total energy plant.
10. Evaluate economic feasibility of installing a large solar energy addition to an existing central plant.

COMPUTER PROGRAM

The computer program DOE 1.4 (formerly CAL-ERDA) was used to arrive at all individual building energy consumption figures and most Energy Conservation Investment Program projects energy savings. This program was developed jointly by the State of California and the United States Energy Research and Development Administration.

GENERAL OVERVIEW

All information used in the preparation of a computer model and the development of ECIP is from field data or post supplied documents. All buildings in the area (except similar family housing units) were surveyed and all pertinent information recorded. This included occupancy schedules, equipment operation schedules, building architecture, type and condition of heating and cooling systems and lighting systems. ECIP projects were then developed.

Computer models of 187 buildings that best represented all post area buildings were developed. The results of these computer runs provided the information to accurately assess ECIP projects, selective energy plants and total energy plant.

* * * * *

PART II

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

In the interest of energy conservation many projects can be implemented. Table II-1 indicates the list of possible Energy Conservation Investment Program projects.

ENERGY CONSERVATION

There are many areas where energy conservation opportunities are justified. The solid waste plant and modification to the hospital are the two best single energy saving projects.

Other large areas of saving potential include maintenance projects, replacement of old systems and system controls.

energy savings should be given in MBTU

The total annual energy savings for all the projects suggested is $2,686,790. Many buildings have more than one project assigned to them. The total energy savings for these buildings will be somewhat less than that shown if all projects are implemented. These totals when compared to FY 1979 energy consumption represent a 63 percent decrease in fuel oil consumption, a 25 percent decrease in natural gas consumption, and a 13 percent decrease in electrical consumption.

should be compared to baseline year FY75.

All central plants except Central Plant 909 have been studied. The main area for energy conservation is chiller optimization. This can be performed by tying into the existing computer system. This project represented a $72,438 per year savings. The initial cost is $61,046 for a pay back of 0.8 years.

SOLAR PROJECTS

Four solar projects were studied. Two projects for swimming pool heating using two different types of collectors were evaluated. A new generation collector (the "Ramada" collector) had a pay back of 11.1 years while the system utilizing a conventional collector took 24.8 years to pay back.

One solar project used solar heated water to heat boiler makeup water at Central Plant 486. This project saved $340 per year at a cost of $34,450 for a pay back of 95.6 years.

The other solar project uses solar heated water for domestic hot water supply. The savings are $250 per year at a cost of $58,810. The pay back is 228 years.

Solar applications to a central plant are limited. The initial cost of the solar system required to make available the energy that is needed in

a central system is extremely high. This high cost to Btu output ratio limits the use of solar.

REFUSE DERIVED FUELS

A solid waste utilization plant could be added to Central Plant 8073. This plant would operate 24 hours per day, seven days per week. The plant would be capable of burning 259 tons of refuse per week. This plant would save $997,545 per year at an initial cost of $1,711,753. This provides a pay back of 1.9 years.

EMCS SYSTEMS

An Energy Monitoring and Control System (EMCS) study was performed by a Control Contractor. This stüdy has been reviewed and is acceptable. The Contractor has overstated energy savings in some areas. These areas have been modified and a pay back of 5.7 years in place of the Contractor's 3.9 years has been suggested. The E/C ratio has been modified to 66.4 and a benefit to cost ratio of 2.04. With these modifications the project is still viable.

SELECTIVE AND TOTAL ENERGY

Table II-2 is a summary of initial Capital Cost, Net Maintenance Costs, Life Cycle Energy Cost Savings and Net Life Cycle Cost for the most cost effective Selective Energy Plant at each plant site and the Total Energy

Plant. For a description of the systems involved at each site refer to Parts III, IV and VI, Selective Energy Plants, Total Energy Plant and Solar Energy Utilization in a Selective Energy Plant respectively in the Integrated Energy Master Plan Report.

Only two of the plants studied have a positive Net Life Cycle Cost, IC and II. This is due to the use of fuel oil at existing Central Plant 8073. Currently the post is paying $1.29/gal for No. 2 fuel oil.

The other plants are severely affected by the low rates for natural gas currently being paid ($1.52/mcf). These low rates keep the Life Cycle Energy Cost Savings low and not capable of overcoming the relatively high Initial Capital Cost or maintenance costs.

RECOMMENDATIONS

We recommend the implementation of ECIP projects 1 through 24 (see Table II-1). These projects all meet the standards for funding of ECIP projects (i.e., benefit to cost ratio greater than one, E/C ratio greater than 18, and a pay back within the life of the equipment). Some of these are basically maintenance items and should be implemented immediately.

Two solar projects pay for themselves within their useful life. We do not recommend the installation of the new "Ramada" collectors. These collectors are very new and have not been adequately tested. Also, we do not recommend the installation of a conventional collector array as it does not meet the E/C and Benefit/Cost ratios minimum requirements. The other solar projects do not pay for themselves and are not recommended at this time.

There are four other projects that are marginal: change incandescent street lights to HPS, circulate stratified warm air, change existing electrical heating and cooling systems in family housing units to heat pumps, and insulate walls.

We recommend the street lighting modification project, the circulation of heated air project and the heat pump project all be implemented. Although the E/C ratio is low on one, and the benefit to cost ratio is low on another, they still represent good energy savings with adequate payback periods.

The wall insulation project is not recommended at his time.

It is not recommended that any of the selective energy, total energy or solar projects be initiated at this time.

Although plants IC and II have positive Net Life Cycle Costs, the installation of a solid waste incinerator at the existing central plant would be more advantageous (See Table II-1).

The very low cost of fuel (except fuel oil) does not lend itself to a cogeneration plant at Fort Riley. It does not appear the Post will be experiencing any radical increase in energy costs in the near future.

ENERGY CONSERVATION GOALS

A directive has been issued by the Office of the Chief of Engineers entitled Army Facilities Energy Plan. This plan states that the fort must reduce their total facility and activity energy consumption 25 percent and reduce average annual energy consumption per gross square foot of floor area by 20 percent in existing buildings. This is based on a FY 75 base year. Other goals are:

1. Reduce FY 85 average annual energy consumption per gross square foot of floor area by 45 percent in new buildings compared to FY 75.
2. Derive ten percent of Army facility energy from coal and refuse derived fuels by FY 85.
3. Derive one percent of Army facility energy from solar energy by FY 85.

4. Eliminate use of natural gas by FY 2000.

5. Reduce facility use of petroleum fuels by 75 percent by FY 2000.

In 1975, Fort Riley consumed 2,465,750 MBtu's. This was used in buildings which had a combined square footage of 13,833,410, providing an overall average consumption of 178,246 Btu's per square foot.

In 1979, the Fort consumed 3,217,776 MBtu's. The total occupied square footage was 14,842,060. Giving an overall average consumption of 216,801 Btu's per square foot.

Rather than reducing consumption by 25 percent the Fort is now consuming 21.6 percent more than it did in 1975. This has occurred even though the Fort has taken several steps to reduce energy consumption; i.e., roof insulation, storm windows, caulking and weatherstripping, etc.

The primary reason for the increased energy consumption on a per-square-foot basis is due to the replacement of old warehouse and barracks type structures with more sophisticated and complex facilities. Since 1975, several major building changes have taken place:

1. Additions to Irwin Army Hospital.

2. Completion of Flight Training Facility.

3. Construction of the 8000 series barracks which consume much more energy than the old wooden barracks they replaced.

4. Completion of the "total electric" homes on Custer Hill (199 buildings).

5. Increase in number of buildings that are air conditioned.

These major building changes have resulted in increased energy consumption.

At present the Fort is not deriving any energy from refuse. If the waste incinerator is installed as recommended they will be capable of supplying 3.7 percent of their energy needs from refuse.

The Fort has a solar system used for heating domestic hot water in a barracks building. Further installation of solar systems will not be economically feasible and are not recommended.

The Fort has reduced their dependence on natural gas. This has been accomplished by closing several old barracks that were heated by natural gas. The troops have been transferred to the recently completed 8000 area. These buildings are heated and cooled with No. 2 fuel oil. However the cost per Btu is higher for fuel oil than for gas.

The Fort has also recently completed 199 new total electric homes. The electricity is purchased from KP&L which generates most of its electricity from coal. This reduces their dependence on natural gas but also greatly increases the Fort's cost per Btu.

By implementing all of the recommended ECIP projects, post energy consumption would decrease by approximately 631,602 MBtu to 2,586,174 MBtu or 174,246 Btu's per square foot. This represents a reduction of 24.4 percent from the 1979 level on a per-square-foot basis. This reduced consumption is 2.3 percent below the 1975 level on a per-square-foot basis.

Due to the relocation of troops, additions of new buildings and replacement of many outdated buildings, it will be very difficult for the fort to achieve the goals as outlined previously.

It is our conclusion that unless the post population decreases enough to close some buildings, the goal of 25 percent below the 1975 level is not attainable.

* * * * *

Table II-1
TOTAL ENERGY SAVINGS**

	ECIP I.D.	Project	Econ. Life	Energy Saved (MBtu) Fuel Oil	Nat. Gas	Elec.	Annual Engr Saved ($)	Initial Capital Cost ($)	Ben/ Cost Ratio	E/C Ratio	Payback Period
1.	I	Repl Air Fltr	1	—	—	44,164	$140,000	$20,089	6.9	2,323	0.2
2.	G	Seal Vnt Shft	25	—	12,722	—	32,058	11,205	57.4	1,204.5	0.3
3.	C	Night Stbck	15	9,775	46,840	—	252,270	160,326	26.5	373.1	0.6
4.	K	150wl to 250 HPS	25	—	—	1,333	9,345	15,033	8.4	81.4	1.5
5.	K	300wl to 400 HPS	25	—	—	904	4,506	7,142	9.5	121.0	1.5
6.	S	Chil Optim	15	—	—	11,342	39,955	61,046	7.2	196	1.6
7.	VIII	Sld Wst Util	20	78,055	—	-,292	997,545	1,711,753	11.4	43.6	1.9
8.	P	VAV Hosp.	25	—	53,705	42,573	269,746	683,565	7.5	148.8	2.4
9.	K	Incan to Fluor	25	—	—	2,594	13,798	37,820	5.4	68.0	2.5
10.	K	Ballast to Discnt	25	—	—	2,202	7,240	19,305	3.3	121.0	2.5
11.	Q	Ch Ppng: B.7210	25	—	—	382	1,210	3,557	6.8	118.0	2.7
12.	D	Stm Rad Cntl	15	—	79,391	—	176,681	638,660	3.6	116.5	3.4
13.	R	Ch W Pmp: B.7210	25	—	—	1,681	5,129	19,080	5.5	93.3	3.5
14.	U	Boil. Contr.	15	—	940	—	2,360	13,880	2.8	7.4	5.4
15.	M	Flue Dampers	15	—	12,732	—	31,957	195,154	2.1	68.9	5.8
16.	F	Insulate Roof	25	—	13,021	—	33,157	217,966	3.0	64.0	6.2
17.	J	Flow Limiters	25	—	47,458	1,450	123,716	883,455	2.8	58.5	6.8
18.	K	Mer. Vap. to HPS	25	—	—	434	1,709	12,487	2.3	32.0	6.8
19.	A	Boil. Repl.	25	—	71,020	—	178,260	1,402,030	2.5	53.5	7.4
20.	T	Boil. X-Tie	25	—	3,816	—	5,625	55,560	1.2	68.7	9.9
21.	B	Comb. Air	25	—	7,110	—	17,850	191,050	1.8	39.3	10.1
22.	IX	Sol Ht Pol (NEW)	25	1,496	—	—	20,615	241,130	1.7	6.6	11.1
23.	L	Ind. Elec. Mtrg.	25	—	—	54,687	98,061	1,190,020	2.0	48.4	11.5
24.	O	Ht. Recov: B.486	25	—	—	191	479	5,581	1.5	37.6	14.4
25.	K	Incan. St. to HPS	25	—	—	1,978	10,280	157,518	1.0	13.0	14.5
26.	H	Circ. Htd. Air	25	—	2,110	—	5,271	85,947	0.8	25.8	15.4
27.	N	Heat Pumps	25	—	—	28,780	91,230	1,702,156	1.0	17.9	17.7
28.	IX	Sol ht Pol (CON)	25	1,496	—	—	20,615	543,180	0.8	2.9	24.8
29.	E	Insul. Walls	25	—	38,060	—	95,530	3,316,749	0.6	12.1	32.9
30.	IX	Sol Pht BLR MU	25	—	136	—	340	34,450	0.2	4.2	95.6
31.	IX	Sol Ht WT (Dom)	25	—	100	—	252	49,400	0.1	1.8	204
		Total		89,326*	389,161*	194,403*	$2,686,790*	$13,686,294			
						Elec	Σ Savings	C	B/C	E/C	

*Totals will decrease if all projects are implemented due to overlap of projects on many buildings.

**FY 83 Costs.

Table II-2

Life Cycle Cost Summary

Plant	Initial Capital Cost ($1,000)	Net Maintenance and Operating Costs ($1,000)	Life Cycle Energy Cost Savings ($1,000)	Net Life Cycle Cost ($1,000)
IA	3,331	1,558	-530	-5449
IB	5,336	1,472	3,285	-3523
IC	1,666	1,033	11,080	8,381
II	7,886	2,125	11,540	1,529
III	2,624	2,440	620	-3814
IV	766	512	350	-928
V	4,654	2,576	960	-6270
VI	766	1,697	-880	-3343
Tot. Engr.	69,412	8,238	45,103	-31,947

USENG2.EMP

TABLE IC
FY 1979
ENERGY CONSUMPTION

FUEL	QUANTITY	EQUIV. BTU X 10^6	% OF TOTAL
NAT. GAS	1,494,365 MCF	1,540,690	47.89
ELECTRICITY	132,202 MWH	1,533,543	47.66
NO. 6 FUEL OIL	—	—	—
NO. 2 FUEL OIL	1,023,789 GAL	142,000	4.41
PROPANE	16,244 GAL	1,543	.04
LNG	—	—	—
COAL	—	—	—
SOLAR	*	*	*

*NEGLIGIBLE CONSUMPTION

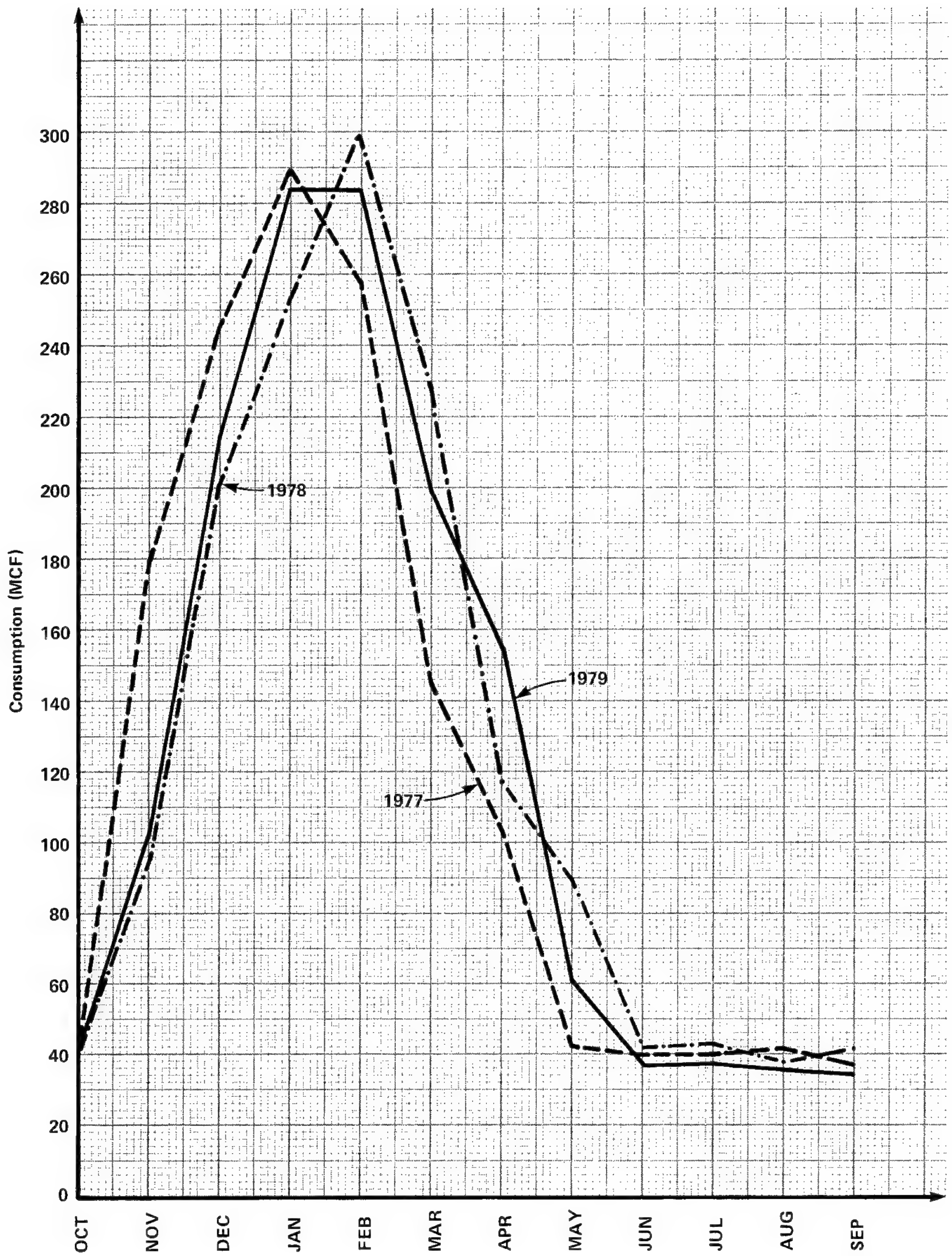

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Figure 1
POST NATURAL GAS CONSUMPTION

USENGEMP 78-808-4 FT. RILEY ENERGY STUDY

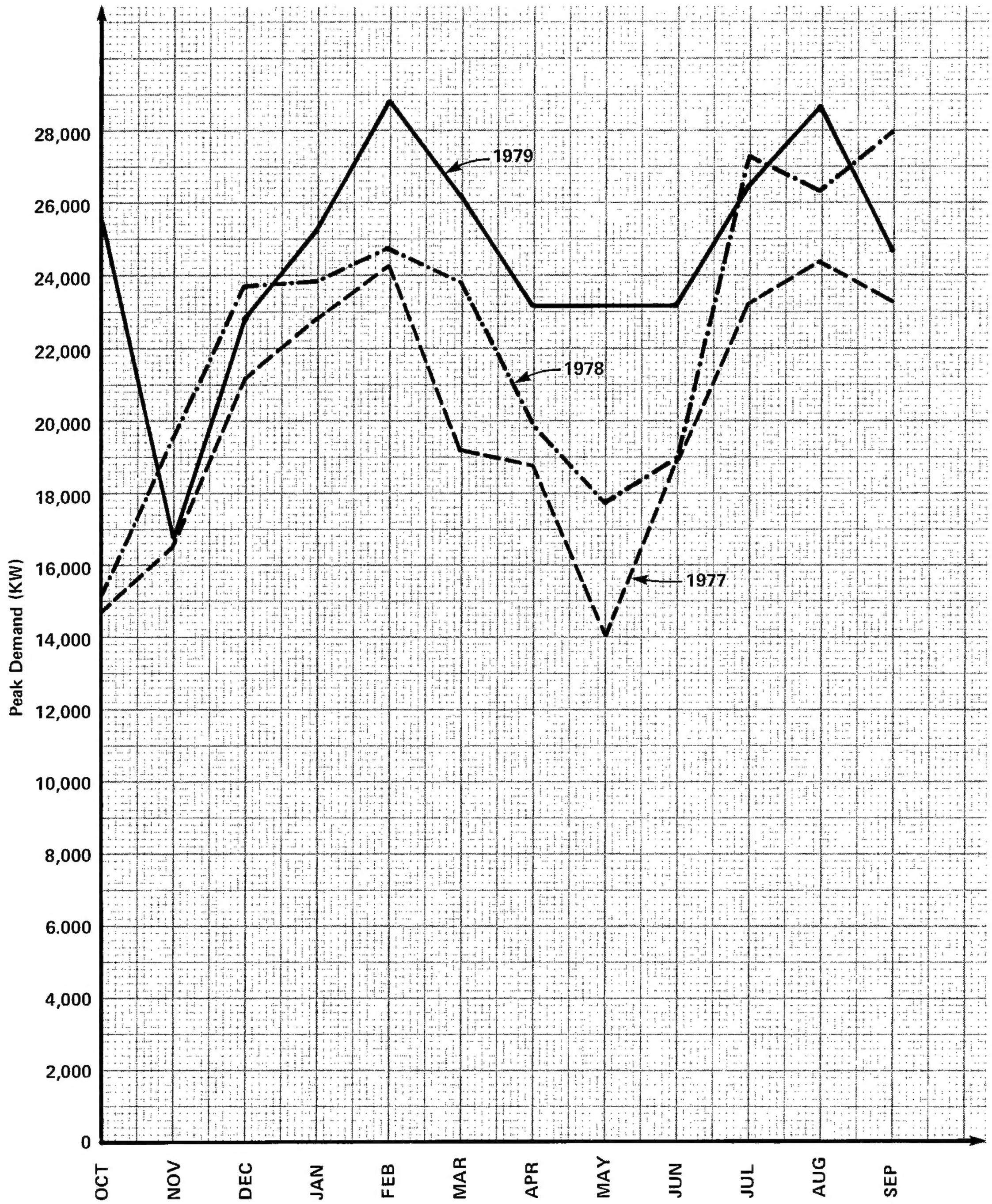

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Figure 2
POST ELECTRICAL PEAK DEMAND

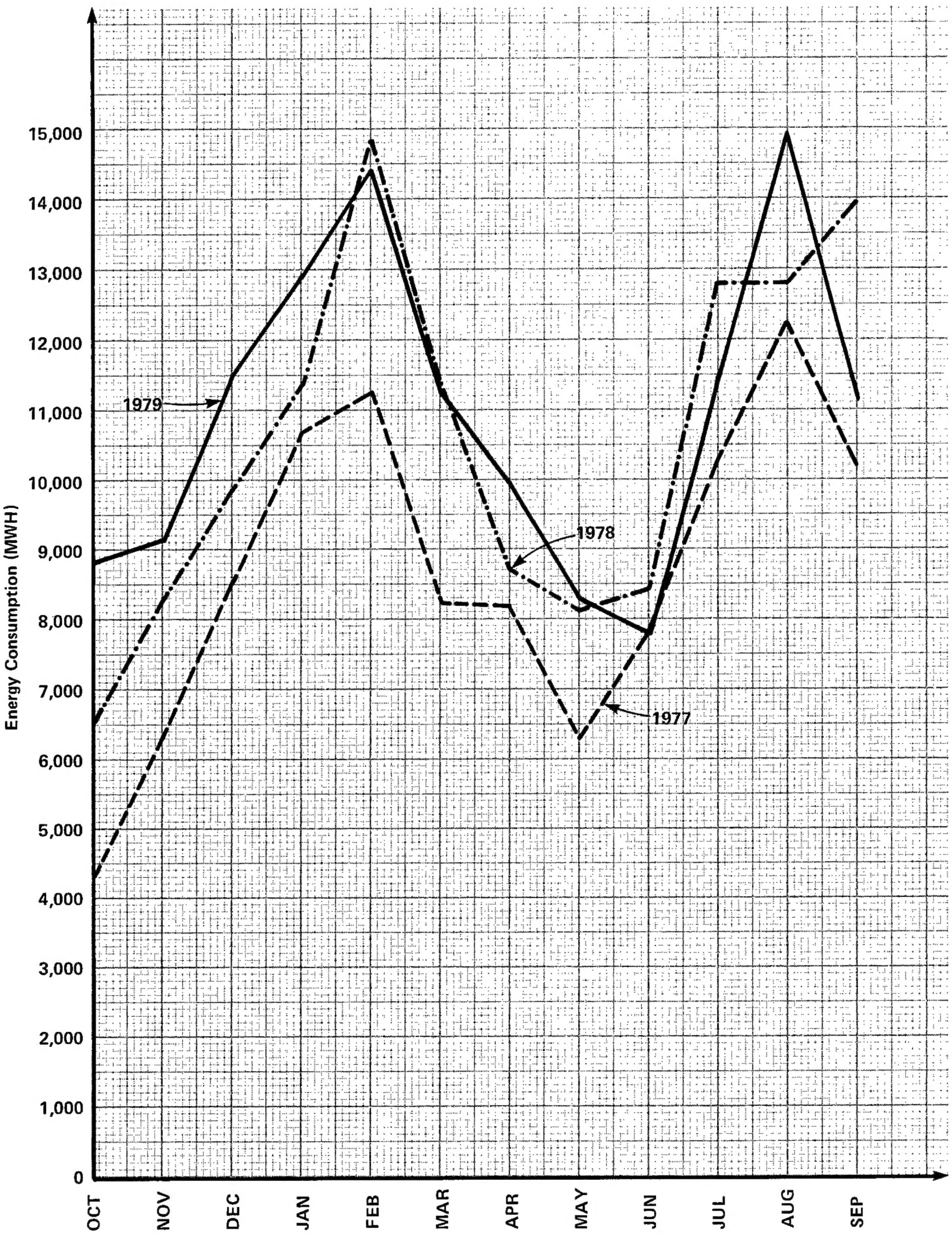

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Figure 3
POST ELECTRICAL CONSUMPTION

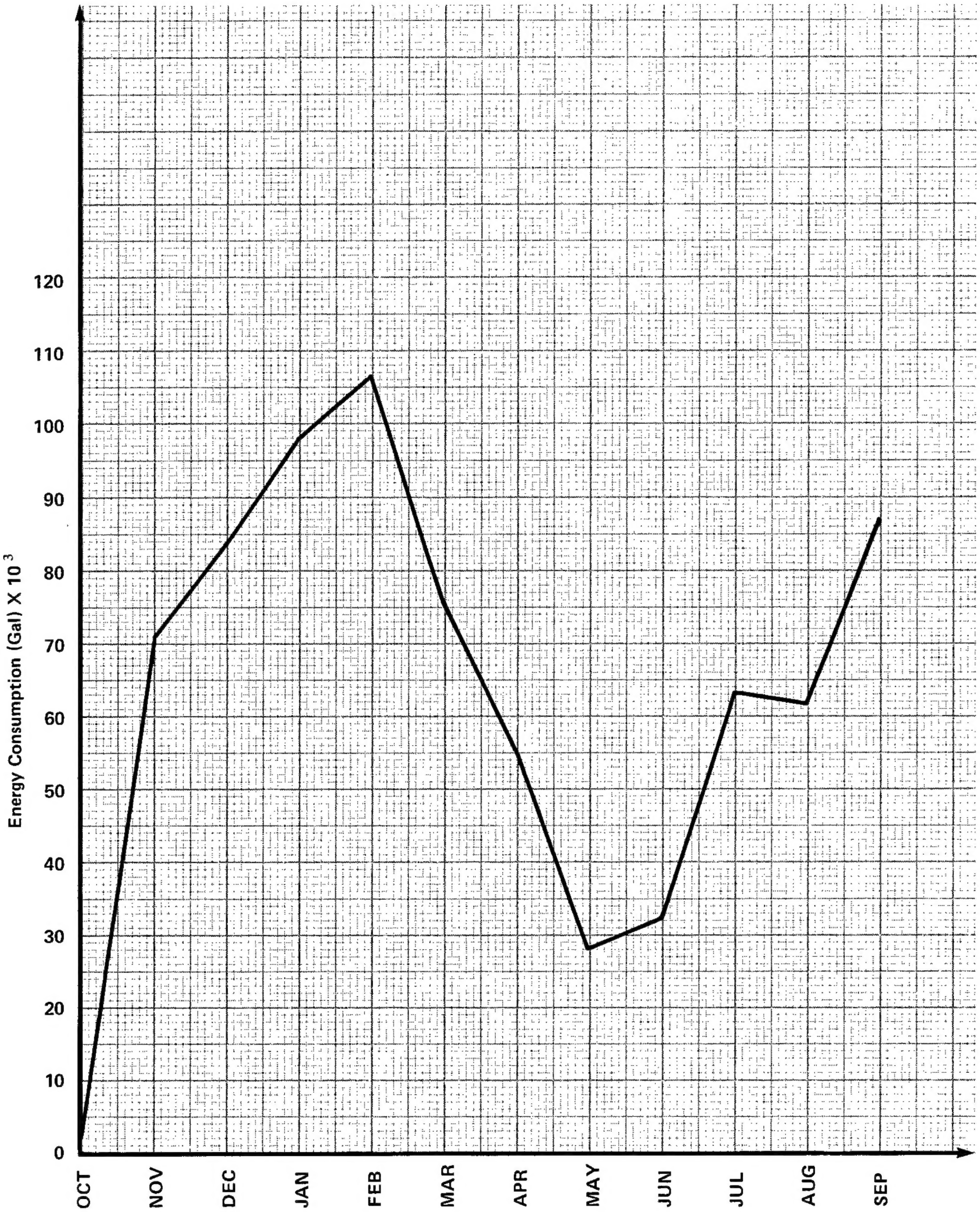

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Figure 4

POST AVERAGE NO. 2 FUEL OIL CONSUMPTION

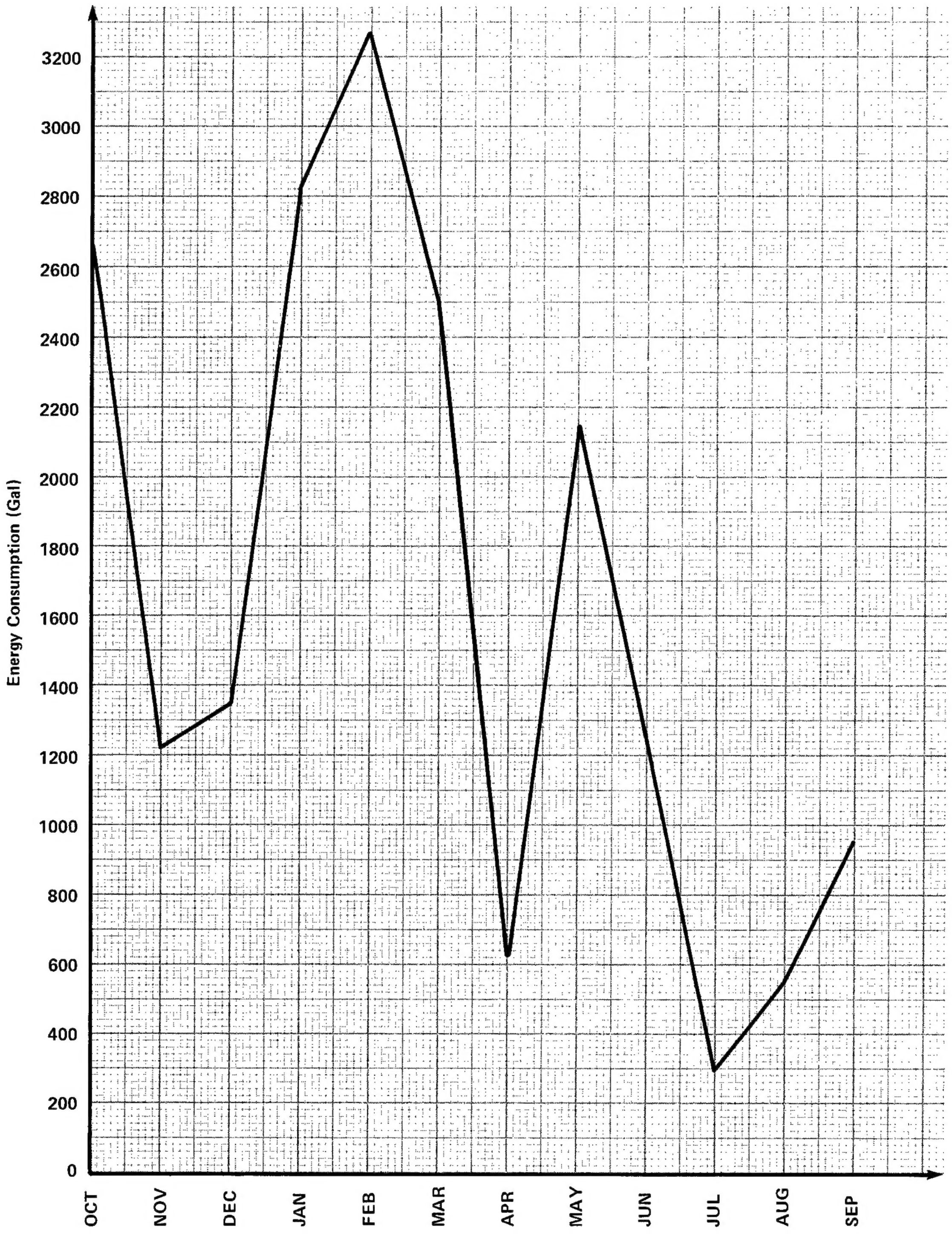

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Figure 5
POST AVERAGE PROPANE CONSUMPTION